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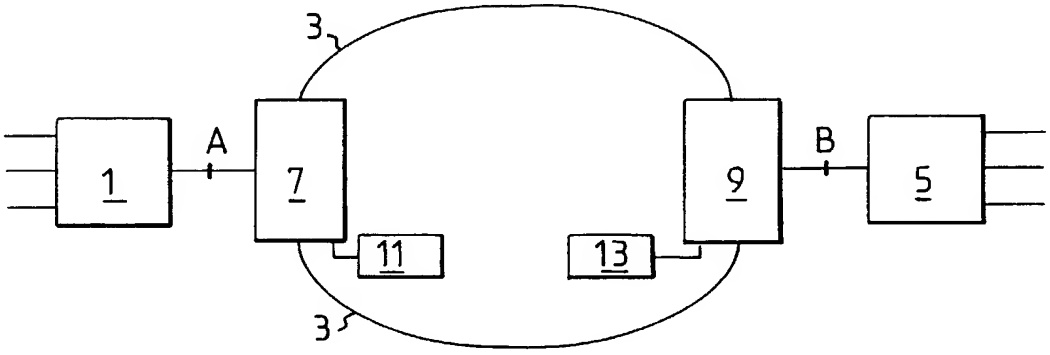
(54) Title: METHOD AND APPARATUS FOR TRANSPARENT TRANSMISSION BETWEEN A TDM NETWORK AND A PACKET OR CELL BASED NETWORK



(57) Abstract: A method of transparent transmission between a TDM network and a packet or cell based network is disclosed, comprising the following steps performed in a unit interconnecting the TDM network and the packet or cell based network: storing each byte received on a channel in a buffer, comparing the content of the buffer to a predetermined bit sequence. If every byte in the buffer matches the bit sequence, the content of the buffer is discarded; otherwise the content of the buffer is packed in a packet or cell and transmitted through the packet or cell based network.In a corresponding unit interconnecting the packet or cell based network and the TDM network it is determined when a packet or cell relating to a particular channel should be expected and, if an expected packet or cell is not received, a frame is generated and transmitted in the TDM network.

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Method and apparatus for transparent transmission between a TDM networks and a packet or cell based network.

Technical Field

The present invention relates to communications systems, and in particular to the communication between circuit switched and packet or cell based communications systems.

Description of Related Art

It is a strong desire in all types of communication systems to increase the capacity to transport payload through the system.

Several known solutions strive to achieve this, usually by means of coding. Typically, known bit sequences that occur frequently in the system are identified and associated with shorter codes. When such a bit sequence occurs, it is then replaced by the corresponding shorter code. The codes and what they signify must be stored in tables at both ends of the encoded connection, that is, at the point where the bit sequence is replaced by the code and at the point where the original bit sequence is restored. One such frequently occurring bit sequence in most systems is the one signifying "no information". This bit sequence is therefore often replaced by a shorter code. In this way, the amount of information transmitted when there is no useful information is reduced, but not completely eliminated.

Object of the Invention

It is an object of the invention to provide an apparatus and a method for reducing the bandwidth requirement in a communication system.

Summary of the Invention

This object is achieved according to the invention by means of a first apparatus for communication between a Time Division Multiplex (TDM) network and a packet or cell based network, comprising

buffer means for receiving and storing bytes, or words, originating from one connection in the TDM network,

comparing means for comparing the content of at least one of the bytes, or words, in the buffer to a predetermined bit sequence when the buffer is full;

cell or packet transmission means for transmitting or discarding the content of the buffer in dependence of the result of the comparison.

A second apparatus for communication between a TDM network and a packet or cell based network, comprising

clock means for determining when a packet or cell related to one particular connection in the TDM network should be expected from the packet or cell based network,

frame generation means for generating a frame comprising bytes, or words, of a predetermined pattern if an expected packet or cell was not received;

TDM transmission means for transmitting the generated frame.

The object is also achieved according to the invention by a method of compressing information transmitted from a TDM network through a packet or cell based network to the same or another TDM network,

characterized in that it comprises the following steps performed in a unit interconnecting the TDM network and the packet or cell based network:

- for each channel in the circuit switched network, storing each byte, or word, in a buffer,
- when the buffer is full, comparing the content of the buffer to a predetermined bit sequence, and
  - if every byte, or word, in the buffer matches the predetermined bit sequence, discarding the content of the buffer,
  - if at least one byte, or word, in the buffer does not match the predetermined bit sequence, packeting transmitting the content of the buffer in a packet or cell and transmitting the packet or cell through the packet or cell based network.

Preferably, the method also comprises the following steps:

- in another unit interconnecting the same or another TDM network with the packet or cell based network, determining when a packet or cell relating to a particular channel should be expected;

if an expected packet or cell is not received, generating a frame of the predetermined bit sequence and transmitting the frame in the TDM network.

These apparatuses and this method ensure that a bit sequence that occurs frequently in the network may not have to be transmitted through the packet or cell based network, thereby saving bandwidth in this network. This is achieved without the need for tables. Unlike some other compression methods this compression function enables 100% bit recovery.

Preferably, the first and second apparatus in such a way that the first apparatus removes idle cells where the traffic enters the packet or cell based network and the second apparatus reinserts the cells where the traffic again enters the TDM network.

In a preferred embodiment the comparing means of the first apparatus is arranged to compare the content of every byte, or word, in the buffer to the predetermined buffer and that the transmission means is arranged to discard the content of the buffer only if every byte in the buffer matches the predetermined bit sequence. In this embodiment the frame generation means of the second apparatus is arranged to generate a frame of bytes of one particular bit sequence when an expected packet or cell is not received.

In another embodiment, the transmission means is arranged to discard the content of the buffer only if every byte, or word, in the buffer matches the last byte of the previous cell, and the frame generation means is arranged to generate a frame of bytes

similar to one of the bytes of the last packet or cell received related to the connection.

In this way, bit sequences of more than one type may be removed, still without the need for tables.

Brief Description of the Drawings

In the following embodiments of the invention will be discussed in more detail, with reference to the appended drawings, in which

Figure 1 illustrates a typical telecommunications network in which the invention may be applied;

Figure 2 shows the connection between an access network, or a local exchange, and a cell or packet based transport network according to the invention.

Detailed Description of Embodiments

Figure 1 illustrates a type of network commonly used in telecommunications today. Subscribers (not shown) are connected to an access network or an access node 1. The access network is connected, through a transport network 3, to a local exchange 5. The local exchange 5 is connected to other units in the network, such as other exchanges and/or other transport networks, in ways well known in the art. More access networks and/or exchanges may be connected to the transport network; however, for clarity only the units needed for the discussion are shown.

In the embodiment shown in Figure 1, the transport network is assumed to be an Asynchronous Transfer Mode (ATM) network, capable of transmitting with the Constant Bit Rate (CBR) or Variable Bit Rate in real time (VBR-rt) service type. In order for the transport network 3 to be transparent, the bit stream at a point A between the access network 1 and the transport network 3 and at a point B between the transport network 3 and the local exchange 5 has to be exactly the same.

The access network 1 performs, among other things, a concentration function. It also multiplexes traffic coming from a number of subscribers onto one cable. The method most commonly used for this is called Pulse Code Modulation (PCM). With PCM, 32 connections of 64kbit/s each are multiplexed to one bit stream of 2Mbit/s. In the United States, 24 connections are instead multiplexed to one bit stream of 1.5Mbit/s. The actual number of channels, or bit rate, is of no importance to the method according to the invention.

On a 64 kbit/s connection the information is carried in bytes of eight bits each, or octets. A 2 Mbit/s PCM frame comprises 32 time slots numbered from 0 to 31, each of which is able to carry an octet. The time slots having the same number in a sequence of PCM frames constitute a channel corresponding to one 64 kbit/s connection.

In the access network 1, the traffic is circuit switched and therefore arrives at the packet or cell based transport network 3 at a fixed rate. In the transport network 3, the traffic is handled according to the ATM protocol. At the interface between the access network 1 and the transport network 3, therefore, there is a first converting unit 7. At the interface between the transport network 3 and the local exchange 5 there is a second converting unit 9 similar to the first converting unit 7. Associated with the first converting unit 7 there is a first buffer unit 11. Associated with the second converting unit 9 there is a second buffer unit 13. As is known in the art, the buffer unit 11 has one buffer for each channel. Each buffer stores the number of bytes that goes into one cell, so that the whole buffer will be filled with bytes, or octets, received on the relevant channel. When the buffer is full, it is packed as a cell and transmitted through the transport network and the procedure starts over.

Since the traffic is received at a fixed rate, the buffer gets filled and its content is packed as a cell or packet and transmitted at regular, well-defined intervals. The second converting unit 9 therefore receives cells corresponding to a particular PCM

channel in the transport network 1 at regular intervals, with a predefined maximum deviation.

According to the invention, the first converting unit 7 comprises logic for examining each buffer, or each cell that is to be transmitted, and determining if it contains useful information. If every octet in the buffer, or cell, comprises the "no information" bit sequence, the whole cell is discarded, i.e. not transmitted. The bandwidth that would have been taken up by this cell can then be used for other information. If, on the other hand, one or more octets comprise a bit sequence different from the "no information" sequence, the whole cell is transmitted.

In the second converting unit 9, cells corresponding to a particular buffer in the first converting unit 7 are expected to arrive at substantially regular intervals. If a cell is not received when expected, or after a predefined maximum delay, the second converting unit therefore determines that the cell probably was not transmitted from the first converting unit 7, because it only comprised "no information" bit sequences. The second converting unit 7 therefore adds to the bit stream either an ATM cell in which the payload comprises only such bit sequences, or a sequence of as many such bit sequences as goes into a cell or packet, depending on the point in the network in which the information is added.

Usually, certain channels in a PCM link, such as channel 16, are used to carry control information. Cells corresponding to this channel will therefore always be transmitted.

In the opposite direction information may be handled in the same way, stored in the second buffer unit 13 transmitted through the access network and received by the first converting unit 7, which adds information in the same way as described above if a cell is not received. The transport network may of course also be located, and

perform the same function, between two local exchanges or between two access networks.

The invention has been discussed in the above using 2Mbit/s connections as an example. As already stated the skilled person could easily apply the teachings to 1.5Mbit/s connections. The method according to the invention can also be applied to higher-order connections, i.e. multiples of 2Mbit/s or 1.5Mbit/s used in telecommunications connections. In any case the PCM frame received is demultiplexed into individual 64 kbit/s channels before being handled according to the invention.

It would of course be possible to use a solution according to the invention to remove more than one type of bit sequence. This might, however, require a code to be added to the removed sequence to indicate which sequence was removed, and a cell would nevertheless have to be transmitted. Therefore the invention is more advantageous if only one type of bit sequence is removed.

In an alternate embodiment sequences of any bit sequence could be removed. The first cell or packet comprising only a particular bit sequence, would have to be transmitted, but then previous cells or packets comprising only this particular bit sequence could be withheld. Only when there is a change will there be a need to transmit a cell. In this way, the receiving converting unit would always know that if no cell or packet is received, a cell or packet similar to the last one received should be generated. Alternatively, only the last byte of a cell or packet would have to be examined, and there would be no need to transmit a cell that only consisted of one of the predefined bit sequences. This may be done for any bit sequence once one or more cells or packets comprise only one particular bit sequence, or may be restricted to a number of predefined bit sequences.

Figure 2 shows in more detail the interface between the TDM network and the packet or cell based network according to the invention. The interface is formed by a converting unit like the one shown in Figure 1, which is in Figure 2 denoted 107.

For transmission from the TDM network to the cell or packet based network the converting unit 107 has at least one input port 109 for receiving incoming TDM frames from the TDM network. The frames have already been demultiplexed into single channels, each usually carrying a 64kit/s connection. The converting unit also comprises a buffer 111, 111', 111" for each channel that may be received from the TDM network. In each buffer 111, 111', 111" the bytes received on the appropriate channel are stored until the buffer is full. Comparing means 113 are present to compare the bytes in a buffer to a predetermined pattern, once the buffer is full. The predetermined pattern is stored in a memory unit 115 in or in connection to the comparing means. If all bytes in the buffer correspond to the predetermined pattern, the entire content of the buffer is discarded, if not, the content of the cell is packetized and transmitted on an appropriate output port 117 in the way common in the art.

The predetermined pattern may be one specific pattern, or one of a number of predetermined patterns, as described in connection with Figure 1. If more than one predetermined pattern is to be used, the memory unit 115 must be able to store the last byte transmitted for each channel, and, if applicable, the predetermined bit sequences that may be discarded.

For transmission in the opposite direction the converting unit 107 also comprises means, i.e. one or more input ports 119 for receiving packets or cells from the cell or packet based network and clock means 121 for determining when a cell or packet should be received for a particular connection. The clock means co-operates with frame generation means 123 in such a way that if the clock means 121 determines that a cell that should have been received has not been received within a predeter-

mined maximum delay period, it orders the frame generation means 123 to generate a frame, which is transmitted via an output port 125. Afterwards, of course, the frames may be multiplexed to the appropriate level in the way generally used in TDM systems.

The content of the generated frame depends on the embodiment. In the simplest embodiment, where only bytes of one particular bit sequence may be discarded, the content is always the same. Alternatively, if more than one bit sequence may be discarded, the frame generation means 123 comprises or is connected to memory means 127 for storing the last byte transmitted for each connection.

The converting means 107 may of course be implemented as two different units, one for each transmission direction.

Claims

1. An apparatus for communication between a TDM network and a packet or cell based network, comprising

buffer means (111, 111',111") for receiving and storing bytes, or words, originating from one connection in the TDM network,

comparing means (113) for comparing the content of at least one of the bytes, or words, in the buffer (111, 111', 111") to a predetermined bit sequence when the buffer is full;

cell or packet transmission means (117) for transmitting or discarding the content of the buffer in dependence of the result of the comparison.

2. An apparatus according to claim 1, characterized in that the comparing means (113) is arranged to compare the content of every byte, or word, in the buffer (111, 111', 111") to the predetermined bit sequence and that the transmission means (117) is arranged to discard the content of the buffer only if every byte, or word, in the buffer matches the predetermined bit sequence.

3. An apparatus according to claim 1 or 2, wherein the transmission means (117) is arranged to discard the content of the buffer only if every byte, or word, in the buffer matches the last byte, or word, of the previous cell.

4. An apparatus for communication between a TDM network and a packet or cell based network, comprising

clock means (121) for determining when a packet or cell related to one particular connection in the TDM network should be expected from the packet or cell based network,

frame generation means (123) for generating a frame comprising bytes, or words, of a predetermined pattern if an expected packet or cell was not received;

TDM transmission means (125) for transmitting the generated frame.

5. An apparatus according to claim 4 wherein the frame generation means (123) is arranged to generate a frame of bytes, or words, of one particular bit sequence when an expected packet or cell is not received.

6. An apparatus according to claim 4 or 5, wherein the frame generation means (123) is arranged to generate a frame of bytes, or words, similar to one of the bytes, or words of the last packet or cell received related to the connection.

7. A method of compressing information transmitted from a TDM network through a packet or cell based network to the same or another TDM network, characterized in that it comprises the following steps performed in a unit interconnecting the TDM network and the packet or cell based network:

- for each channel in the circuit switched network, storing each byte, or word, in a buffer,
- when the buffer is full, comparing the content of the buffer to a predetermined bit sequence, and
    - if every byte, or word, in the buffer matches the predetermined bit sequence, discarding the content of the buffer,
    - if at least one byte, or word, in the buffer does not match the predetermined bit sequence, packeting transmitting the content of the buffer in a packet or cell and transmitting the packet or cell through the packet or cell based network.

8. A method according to claim 7, further comprising the following steps:

- in another unit interconnecting the same or another TDM network with the packet or cell based network, determining when a packet or cell relating to a particular channel should be expected;
- if an expected packet or cell is not received, generating a frame of the predetermined bit sequence and transmitting the frame in the TDM network.

9. A method according to claim 7 or 8, wherein the predetermined bit sequence is a fixed bit sequence stored in a memory unit (115).

10. A method according to claim 7 or 8, wherein the predetermined bit sequence is the same as in the last byte, or word, of the last packet or transmitted for the channel.

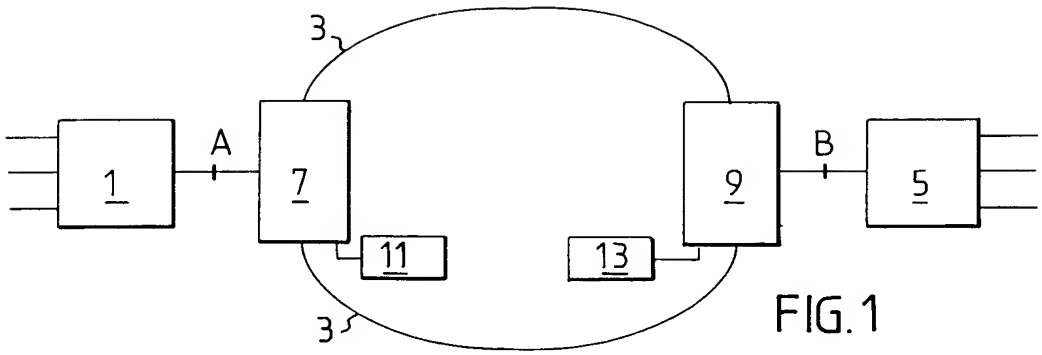
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FIG.1

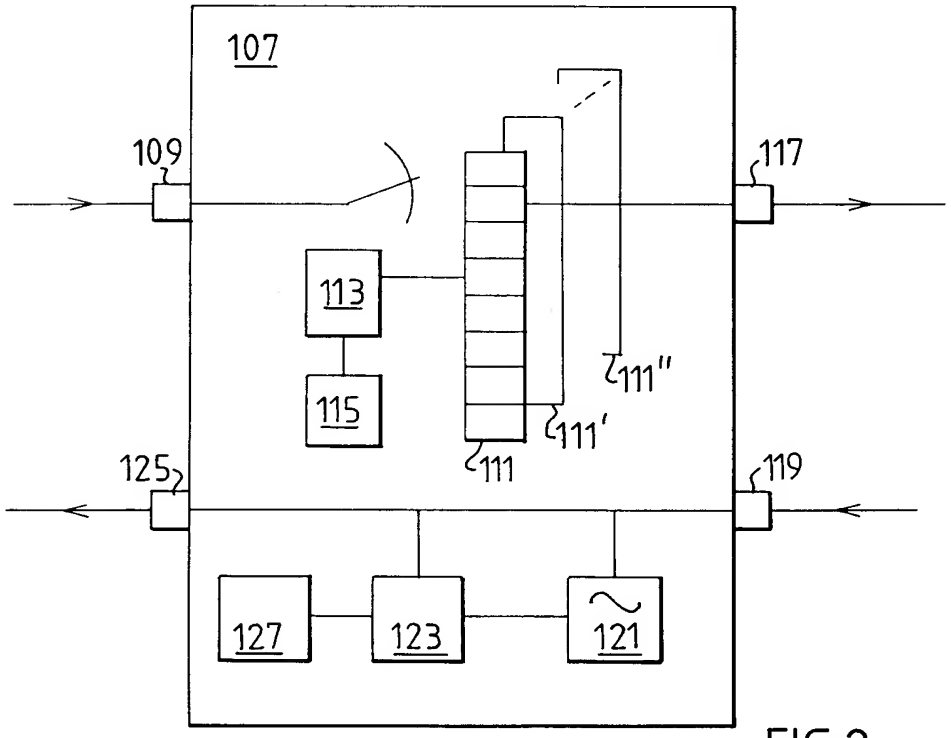
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FIG.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02515

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 12/66
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04L, H03M, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9851113 A2 (NORTHERN TELECOM LIMITED), 12 November 1998 (12.11.98), page 12, line 30 - page 13, line 23; page 15, line 32 - page 16, line 6	1-3,7-10
A	--	4-6
A	WO 9708838 A2 (ERICSSON INC.), 6 March 1997 (06.03.97), page 6, line 25 - page 8, line 17; page 24, line 1 - page 25, line 15	1-10
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

25/02/01

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9851113 A2	12/11/98	AU 7221198 A	27/11/98
		EP 0979566 A	16/02/00
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